BNL-63555

CLOSURE EXPERIMENT – MODTRAN-3 PREDICTION OF DIRECT SOLAR IRRADIANCE USING AS INPUT MFRSR MEASURED AEROSOL OPTICAL THICKNESS AND RADIOSONDE MEASURED ATMOSPHERIC PROPERTIES FOR A CLEAR ATMOSPHERE

R. N. Halthore, M. H. Bergin, S. E. Schwartz, J. J. Michalsky, R. A. Ferrare, and B. N. Holben

American Geophysical Union 1996 Fall Meeting, San Francisco, CA, Dec. 15-19, 1996.

Multi-Filter Rotating Shadowband Radiometers (MFRSR) are employed at the Department of Energy's Atmospheric Radiation Measurement (ARM) sites to measure the total and diffuse hemispherical-surface irradiance in seven bands from 0.3 to 1.1 µm. The direct-normal solar irradiance is obtained as the difference of the total and diffuse components divided by the cosine of the solar zenith angle and corrected for the angular response of the instrument. Based on absolute calibration of the sensors using the Langley method or versions thereof, the atmospheric transmission is evaluated in these bands to determine aerosol optical thickness (AOT) and water vapor column abundance - the most variable components of the atmosphere that affect radiative transfer. To establish a level of confidence in these measurements, they are compared to the corresponding quantities derived from sunphotometers. Independent measurements of water column abundance are also available from microwave radiometers and radiosondes. A comparison between all these different quantities and types of measurement will be presented for three periods - April 1994, October 1995, and April 1996. Calibration methods and their uncertainties will be discussed. Comparison of the sunphotometer and MFRSR derived values showed that the AOTs were generally within the expected uncertainty of ±0.02, but the nature of disagreement - namely systematic differences dependent on airmass - showed that factors other than calibration uncertainty may be important. The radiative transfer model MODTRAN-3 is used to predict the direct surface solar irradiance in the wavelength range 0.3-5.0 µm, using as input, the MFRSR measurement of AOT with its wavelength dependence, radiosonde measurements for atmospheric characterization, and ozone and carbon-dioxide abundance from climatology. The closure experiment consists of comparing the MODTRAN-3 predicted value with the direct-normal short-wave irradiance measured by a calibrated pyrheliometer. Results show that the model over-predicts the measured value by 2% (or 15 W m^{-2} in a measured value of 850 W m^{-2} on October 18, 1995 at 1835 UT) during the ARM Enhanced Shortwave Experiment (ARESE) period. Factors that affect this comparison are pyrheliometer calibration, aerosol optical properties including optical thickness, single scattering albedo and phase function, and loading and absorption of trace gases. An analysis of the impact of each on this comparison will be presented.

Research by BNL investigators was performed under the auspices of the U.S. Department of Energy under Contract No. DE-AC02-98CH10886.